Exploring Bitter Taste Origins in Faba Beans Using Combined Approaches

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Faba bean is a promising ingredient for the development of sustainable and nutritionally valuable plant-based foods. However, its wider use is limited by the presence of off-flavours, particularly bitterness, which strongly affects consumer acceptance. While previous research on pulses has mainly examined volatile compounds responsible for off-notes, the role of non-volatile molecules in bitterness remains insufficiently understood. Recent studies on peas, soybeans, and lupins have highlighted the involvement of saponins, phenolic compounds, alkaloids, amino acids, and peptides in bitterness, but such investigations remain scarce for faba beans. This study aimed to identify the non-volatile compounds responsible for bitter taste in faba bean fractions and to better understand the influence of process and cultivar selection on taste quality.

Sensory, metabolomic and cellular approaches were combined to characterize the bitterness of 3 air-classified fractions (flour, starch, and protein) obtained from 3 cultivars. First, 21 trained panellists evaluated the bitter intensity of gels containing the different fractions. Significant differences in bitterness were observed according to both the type of fraction and the cultivar. Second, an untargeted metabolomic approach using ultra-high-performance liquid chromatography coupled with diode array detection and high-resolution mass spectrometry (UHPLC-DAD-HRMS) was applied to investigate the origins of these sensory differences. This comprehensive profiling allowed the detection of a large number of non-volatile compounds and showed clear differences between fractions and between cultivars. Third, the sensory data were correlated with those of the metabolomic approach to identify the non-volatile compounds most closely associated with bitterness. A total of 42 non-volatile compounds were tentatively identified as contributing to bitter taste. They belonged to various chemical families, including alkaloids (such as vicine, convicine and their derivatives), amino acids, phenolic compounds, organic acids, and terpenoids. Although βb and DDMP soyaponins are known contributors to bitterness in peas, these compounds were detected in the faba bean fractions without correlating with bitterness. This suggested that their concentrations were too low to contribute to this off-taste and indicated that the bitterness origins differed among pulses. Fourth, the sensory relevance of several highlighted compounds was carried out through a cellular assay targeting human bitter taste receptors (hTAS2Rs). Bitter compounds are known to activate at least one of these 25 receptors, leading to the perception of bitterness. This approach showed that vicine, a specific alkaloid of faba beans, activated the hTAS2R16 receptor, whereas βb soyasaponin activated 11 receptors, including TAS2R42, for which no agonist had previously been reported.

Finally, this multidisciplinary approach provides new insights into the origins of faba bean bitterness and highlights the effect of cultivar and process on taste quality. These findings offer practical perspectives for the agri-food industry. Identifying the compounds that most strongly influence the faba bean bitterness makes it possible to propose strategies for improving their flavour, such as cultivar selection and process optimization. This will promote the development of plant-based ingredients with improved sensory properties, thereby encouraging wider use of faba beans and other pulses as sustainable a source of proteins.

Keywords: faba beans; bitterness; sensory analysis; metabolomic analysis; cellular assays

Reference A. Karolkowski, C. Belloir, G. Lucchi, C. Martin, E. Bouzidi, L. Levavasseur, C. Salles and L. Briand. Activation of Bitter Taste Receptors by Saponins and Alkaloids Identified in Faba Beans (*Vicia Faba* L. *Minor*). *Food Chemistry*, 2023, 426, 136548. https://doi.org/10.1016/j.foodchem.2023.136548